Wherefore, what is claimed is:

1. A process for encoding bi-level images, said process comprising using a computing apparatus to perform the following process actions:

for each pixel location in raster order in the bi-level image,

predicting a binary value for the pixel at a pixel location under consideration based on its context, wherein a context of a pixel refers to predicted values of a prescribed pattern of pixels preceding the pixel in raster order;

determining whether the predicted pixel value matches the actual pixel value for the pixel location under consideration; and

compressing the data concerning at which pixel locations the predicted pixel values match and do not match the actual values using a context-dependent, backward adaptive, Run-Length-Rice encoding technique.

2. The process of Claim 1, wherein the process action of predicting the binary value for the pixel at each pixel location in raster order, comprises the actions of:

assigning a prescribed initial probability value to each of a set of potential context indexes, wherein a context index is a binary word comprising previously predicted binary values of a prescribed pattern of pixels of the bi-level image preceding in raster order a pixel whose value is currently being predicted, and wherein the initial probability value indicates the probability that the pixel whose value is currently being predicted has a first binary value associated with a first of the two colors of the bi-level image based on the predicted values of the prescribed pattern of pixels preceding the pixel being predicted; and

for each pixel location in raster order in the bi-level image,

computing the context index associated with the prescribed pattern of pixels preceding the pixel location under consideration, wherein pixel

locations in the pattern that fall outside the bi-level image are considered to have the first binary value,

identifying the probability value assigned to the computed context index,

whenever the identified probability value indicates that the pixel location under consideration is more likely than not to have the first binary value, assigning as the predicted pixel value for that location the first binary value, and

whenever the identified probability value indicates that the pixel location under consideration is not more likely than not to have the first binary value, assigning as the predicted pixel value for that location the second binary value associated with a second of the two colors of the bi-level image.

3. The process of Claim 2, wherein the first binary value associated with the first of the two colors of the bi-level image is a 0, and the second binary value associated with the second of the two colors of the bi-level image is a 1.

4. The process of Claim 2, wherein the first of the two colors of the bi-level image is white, and the second of the two colors is black.

5. The process of Claim 2, wherein the process action of assigning a prescribed initial probability value to each of a set of potential context indexes, comprises an action of assigning the same initial probability value to each context index, said initial probability being a number indicative of a 0.50 probability that the pixel value has the first binary value.

6. The process of Claim 2, further comprising a process action of adjusting the probability value assigned to the computed context index by increasing it by a prescribed amount if the predicted pixel value of the pixel location under consideration is assigned the first binary value and decreasing it

by a prescribed amount if the predicted pixel value is assigned the second binary value.

7. The process of Claim 6, wherein the probability values are scaled so as to range between 0 and prescribed maximum integer number, and wherein the process action of adjusting the probability value assigned to the computed context index comprises an action of making the adjustments in integer increments.

8. The process action of Claim 7, wherein the process action of adjusting the probability value assigned to the computed context index further comprises the actions of:

whenever decreasing the scaled probability value would result in a value of less than 0, making the probability value 0; and

whenever increasing the scaled probability value would result in a value of greater than the prescribed maximum minus one, making the probability value equal to the prescribed maximum minus one.

9. The process of Claim 7, wherein the prescribed maximum integer number is eight.

10. The process of Claim 1, wherein the process action of determining whether the predicted pixel value matches the actual pixel value for the pixel location under consideration, comprises the actions of:

comparing the predicted pixel value to the actual pixel value of the pixel location under consideration; and

assigning a prediction error value to the pixel location, wherein the prediction error value has a first binary value if the predicted pixel value matches the actual pixel value and a second binary value if the predicted pixel value is different from the actual pixel value.

11. The process of Claim 10, wherein the first binary value associated with the prediction error values is a 0, and the second binary value associated with the prediction error values is a 1.

12. The process of Claim 1, wherein the process action of compressing the data concerning at which pixel locations the predicted pixel values do not match the actual values, comprises the actions of:

assigning a prescribed initial k value to each context index, wherein a k value is used to compute a number representing a string of consecutive, raster ordered, prediction error values having the first binary value;

identifying the k value assigned to the context index computed for the first pixel location in the bi-level image and subsequently for each pixel location that follows in raster order a pixel that triggered a codeword to be established; and

for each pixel location in the bi-level image beginning with the first and proceeding in raster order,

determining if the prediction error value assigned to the pixel location under consideration has the first or second binary value,

whenever the prediction error value assigned to the pixel location under consideration has the first value, taking no action unless the number of preceding pixels locations for which no action has been taken equals the last-identified k value, and if it does equal this k value, establishing a first type of codeword by representing the number of preceding pixel locations for which no action has been taken with a single first value, and

whenever the prediction error value assigned to the pixel location under consideration has the second value, establishing a second type of codeword by representing the prediction error having the second value and the number of preceding pixel locations for which no action has been taken with a second value and a binary word indicating the number of preceding pixel locations for which no action has been taken.

13. The process of Claim 12, further comprising the process action of computing the number representing the string of consecutive, raster ordered, prediction error values having the first binary value from an assigned k value using the equation 2^k.

14. The process of Claim 12, wherein the first value associated with the first type of codeword is a 0, and the second value associated with the second type of codeword is a 1.

15. The process of Claim 12, wherein the process action of assigning a prescribed initial k value to each context index, comprises an action of assigning the same initial k value to each context index, said initial k value being preferably chosen as two.

16. The process of Claim 12, further comprising the process action of whenever a codeword is established, adjusting the k value assigned to the context index associated with pixel location that begins the string of prediction error values represented by that codeword by increasing it by a prescribed amount if the codeword is of the first type and decreasing it by a prescribed amount if the codeword is of the second type.

17. The process of Claim 16, wherein the k values are scaled by multiplying each by a prescribed scaling factor.

18. The process of Claim 17, wherein the prescribed amount that the scaled k values are increased or decreased depends on how many times the k values has been adjusted from its initial value.

19. The process of Claim 18, wherein the prescribed scaling factor equals 16, the prescribed amount that a k value is increased is 3, 3, 4, 5, and 6

for the first through fifth times it is consecutively increased, respectively, and 8 for each time it is consecutively increased after the fifth time.

20. The process of Claim 19, the prescribed amount that a k value is decreased is 0, 3, 6, 6, 8 and 10 for the first through sixth times it is consecutively decreased, respectively, and 12 for each time it is consecutively decreased after the sixth time.

21. A process for decoding a bi-level image encoded by a process that reduces the image data to a series of codewords from which can be derived prediction error values indicating whether the pixel values of each pixel location in the bi-level image had a first binary value or a second binary value, said codewords coming in two types a first of which is a first value representing a number of pixel locations that have a first binary prediction error value and the second of which comprises a second value followed by a binary word that indicates the number of pixel locations preceding a location having a second binary prediction error value that exhibit the first binary prediction error value, said process comprising using a computing apparatus to perform the following process actions:

receiving the series of codewords;

for each pixel location in raster order in a restoration image of the encoded bi-level image;

predicting a binary value for the pixel at the pixel location under consideration based on its context, wherein a context of a pixel refers to predicted values of a prescribed pattern of pixels preceding the pixel in raster order,

deriving a prediction error value for the pixel location under consideration from a received codeword;

comparing in raster order the prediction error assigned to a pixel location of the restoration image and the predicted pixel value for that location using an exclusive OR process such that whenever the prediction error value is

the first binary value the corresponding predicted pixel value is not changed, and whenever the prediction error value is the second binary value the corresponding predicted pixel value is flipped to its opposite binary value; and

designating the result of each prediction error and predicted pixel value comparison as a restored pixel value for the associated pixel location in the restoration image.

22. The process of Claim 21, wherein the process action of predicting a binary value for the pixel at each pixel location, comprises the actions of:

assigning a prescribed initial probability value to each of a set of potential context indexes which is identical to those used in encoding the bi-level image, wherein a context index is a binary word comprising previously predicted binary values of a prescribed pattern of pixels of the bi-level image preceding in raster order a pixel whose value is currently being predicted, and wherein the initial probability value indicates the probability that the pixel whose value is currently being predicted has a first binary value associated with a first of the two colors of a restoration image of the encoded bi-level image based on the predicted values of the prescribed pattern of pixels preceding the pixel being predicted; and

for each pixel location in raster order in the restoration image of the encoded bi-level image upon receiving the first of the series of codewords,

computing the context index associated with the prescribed pattern of pixels preceding the pixel location under consideration, wherein pixel locations in the pattern that fall outside the bi-level image are considered to have the first binary value,

identifying the probability value assigned to the computed context index,

whenever the identified probability value indicates that the pixel location under consideration is more likely than not to have the first binary value, assigning as the predicted pixel value for that location the first binary value, and

whenever the identified probability value indicates that the pixel location under consideration is not more likely than not to have the first binary value, assigning as the predicted pixel value for that location the second binary value associated with a second of the two colors of the bi-level image.

23. The process of Claim 22, wherein the first binary value associated with the first of the two colors of the bi-level image is a 0, and the second binary value associated with the second of the two colors of the bi-level image is a 1.

24. The process of Claim 22, wherein the first of the two colors of the bi-level image is white, and the second of the two colors is black.

25. The process of Claim 22, further comprising a process action of adjusting the probability value assigned to the computed context index by increasing it by the prescribed amount used in encoding the bi-level image if the predicted pixel value of the pixel location under consideration is assigned the first binary value and decreasing it by the prescribed amount used in encoding the bi-level image if the predicted pixel value is assigned the second binary value.

26. The process of Claim 25, wherein the probability values are scaled so as to range between 0 and a prescribed maximum integer number identical to that used in the encoding of the bi-level image, and wherein the process action of adjusting the probability value assigned to the computed context index comprises the actions of:

making the adjustments in integer increments;

making the probability value 0, whenever decreasing the scaled probability value would result in a value of less than 0; and

making the probability value equal to the prescribed maximum minus one, whenever increasing the scaled probability value would result in a value of greater than the prescribed maximum minus one.

27. The process of Claim 21, wherein the process action of deriving a prediction error value for each pixel location in raster order in a restoration image, comprises the actions of:

assigning a prescribed initial k value to each context index that is identical to the value used in encoding the bi-level image, wherein a k value is used to compute a number representing a string of consecutive, raster ordered, prediction error values having the first binary value in the same manner employed in encoding the bi-level image being decoded;

determining if the last-received codeword is of the first or second type;

whenever the last-received codeword is of the second type, assigning prediction error values having the first binary value to the number of previously-unassigned pixel locations in a restoration of the encoded bi-level image in raster order starting with the earliest non-assigned location that are indicated by the binary word component of the codeword and assigning a prediction error value having the second binary value to the pixel location following those newly assigned pixel locations; and

whenever the last-received codeword is of the first type,

identifying the k value assigned to the context index associated with the earliest pixel location in the restoration image not yet assigned a prediction error value, and

assigning prediction error values having the first binary value to the number of previously-unassigned pixel locations that are indicated by the identified k value in the restoration image in raster order starting with the earliest non-assigned location.

28. The process of Claim 27, wherein the first value associated with the first type of codeword is a 0, and the second value associated with the second type of codeword is a 1.

29. The process of Claim 27, further comprising the process action of, upon completion of assigning prediction error values in connection with the processing of the last-received codeword, adjusting the *k* value assigned to the context index associated with pixel location that begins the string of prediction error values just assigned by increasing the *k* value by a prescribed amount employed in the encoding of the bi-level image being decoded if the codeword is of the first type and decreasing the *k* value by a prescribed amount employed in the encoding of the bi-level image being decoded if the codeword is of the second type.

30. The process of Claim 29, wherein the *k* values are scaled by multiplying each by a prescribed scaling factor employed in the encoding of the bi-level image being decoded.

31. A system for encoding bi-level images, comprising:

a general purpose computing device; and

a computer program comprising program modules executable by the computing device, wherein the computing device is directed by the program modules of the computer program to,

assign a prescribed initial probability value to each of a set of potential context indexes, wherein a context index is a binary word comprising previously predicted binary values of a prescribed pattern of pixels of the bi-level image preceding in raster order a pixel whose value is currently being predicted, and wherein the initial probability value indicates the probability that the pixel whose value is currently being predicted has a first binary value associated with a first of the two colors of the bi-level image based on the predicted values of the prescribed pattern of pixels preceding the pixel being predicted for each pixel location in raster order in the bi-level image,

predict a binary value for each pixel location in raster order in the bi-level image by,

computing the context index associated with the prescribed pattern of pixels preceding the pixel location under consideration, wherein pixel locations in the pattern that fall outside the bi-level image are considered to have the first binary value,

identifying the probability value assigned to the computed context index,

assigning as the predicted pixel value for that location the first binary value whenever the identified probability value indicates that the pixel location under consideration is more likely than not to have the first binary value,

assigning as the predicted pixel value for that location the second binary value associated with a second of the two colors of the bi-level image whenever the identified probability value indicates that the pixel location under consideration is not more likely than not to have the first binary value,

adjusting the probability value assigned to the computed context index by increasing it by a prescribed amount if the predicted pixel value of the pixel location under consideration is assigned the first binary value and decreasing it by a prescribed amount if the predicted pixel value is assigned the second binary value,

for each pixel location in raster order in the bi-level image, determine whether the predicted pixel value matches the actual pixel value for the pixel location under consideration by,

comparing the predicted pixel value to the actual pixel value of the pixel location under consideration, and

assigning a prediction error value to the pixel location, wherein the prediction error value has a first binary value if the predicted pixel value matches the actual pixel value and a second binary value if the predicted pixel value is different from the actual pixel value, and

compress the data concerning at which pixel locations the predicted pixel values do not match the actual values using a bi-level image encoding technique.

32. A system for decoding bi-level images encoded by a process that reduces the image data to a series of codewords from which can be derived prediction error values indicating whether the pixel values of each pixel location in the bi-level image had a first binary value or a second binary value, said codewords coming in two types a first of which is a first value representing a number of pixel locations that have a first binary prediction error value and the second of which comprises a second value followed by a binary word that together indicate the number of pixel locations preceding a location having a second binary prediction error value that exhibit the first binary prediction error value, comprising:

a general purpose computing device; and

a computer program comprising program modules executable by the computing device, wherein the computing device is directed by the program modules of the computer program to,

receive the series of codewords,

assign a prescribed initial probability value to each of a set of potential context indexes which is identical to those used in encoding the bi-level image, wherein a context index is a binary word comprising previously predicted binary values of a prescribed pattern of pixels of the bi-level image preceding in raster order a pixel whose value is currently being predicted, and wherein the initial probability value indicates the probability that the pixel whose value is currently being predicted has a first binary value associated with a first of the two colors of a restoration image of the encoded bi-level image based on the predicted values of the prescribed pattern of pixels preceding the pixel being predicted; and

predict a binary value for each pixel location in raster order in a restoration image of the encoded bi-level image by, upon receiving the first of the series of codewords,

computing the context index associated with the prescribed pattern of pixels preceding the pixel location under consideration,

wherein pixel locations in the pattern that fall outside the bi-level image are considered to have the first binary value,

identifying the probability value assigned to the computed context index,

assigning as the predicted pixel value for that location the first binary value whenever the identified probability value indicates that the pixel location under consideration is more likely than not to have the first binary value, and

assigning as the predicted pixel value for that location the second binary value associated with a second of the two colors of the bi-level image whenever the identified probability value indicates that the pixel location under consideration is not more likely than not to have the first binary value,

adjusting the probability value assigned to the computed context index by increasing it by the prescribed amount used in encoding the bi-level image if the predicted pixel value of the pixel location under consideration is assigned the first binary value and decreasing it by the prescribed amount used in encoding the bi-level image if the predicted pixel value is assigned the second binary value,

derive a prediction error value for each pixel location in raster order in a restoration image of the encoded bi-level image from a received codeword,

compare in raster order the prediction error assigned to a pixel location of the restoration image and the predicted pixel value for that location using an exclusive OR process such that whenever the prediction error value is the first binary value the corresponding predicted pixel value is not changed, and whenever the prediction error value is the second binary value the corresponding predicted pixel value is flipped to its opposite binary value, and

designate the result of each prediction error and predicted pixel value comparison as a restored pixel value for the associated pixel location in the restoration image.

33. A computer-readable medium having computer-executable instructions for encoding bi-level images, said computer-executable instructions comprising:

for each pixel location in raster order in the bi-level image,

predicting a binary value for the pixel at a pixel location under consideration based on its context, wherein a context of a pixel refers to predicted values of a prescribed pattern of pixels preceding the pixel in raster order;

determining whether the predicted pixel value matches the actual pixel value for the pixel location under consideration; and

compressing the data concerning at which pixel locations the predicted pixel values match and do not match the actual values by,

assigning a prescribed initial k value to each context index, wherein a k value is used to compute a number representing a string of consecutive, raster ordered, prediction error values having the first binary value,

identifying the k value assigned to the context index computed for the first pixel location in the bi-level image and subsequently for each pixel location that follows in raster order a pixel that triggered a codeword to be established,

for each pixel location in the bi-level image beginning with the first and proceeding in raster order,

determining if the prediction error value assigned to the pixel location under consideration has the first or second binary value,

whenever the prediction error value assigned to the pixel location under consideration has the first value, taking no action unless the number of preceding pixels locations for which no action has been taken equals the last-identified k value, and if it does equal this k value, establishing a first type of codeword by representing the number of preceding pixel locations for which no action has been taken with a single first value, and

whenever the prediction error value assigned to the pixel location under consideration has the second value, establishing a second

type of codeword by representing the prediction error having the second value and the number of preceding pixel locations for which no action has been taken with a second value and a binary word indicating the number of preceding pixel locations for which no action has been taken, and

whenever a codeword is established, adjusting the k value assigned to the context index associated with pixel location that begins the string of prediction error values represented by that codeword by increasing it by a prescribed amount if the codeword is of the first type and decreasing it by a prescribed amount if the codeword is of the second type.

34. A computer-readable medium having computer-executable instructions for decoding bi-level images encoded by a process that reduces the image data to a series of codewords from which can be derived prediction error values indicating whether the pixel values of each pixel location in the bi-level image had a first binary value or a second binary value, said codewords coming in two types a first of which is a first value representing a number of pixel locations that have a first binary prediction error value and the second of which comprises a second value followed by a binary word that together indicate the number of pixel locations preceding a location having a second binary prediction error value that exhibit the first binary prediction error value, said computer-executable instructions comprising:

receiving the series of codewords;

for each pixel location in raster order in a restoration image of the encoded bi-level image,

predicting a binary value for the pixel at the pixel location under consideration based on its context, wherein a context of a pixel refers to predicted values of a prescribed pattern of pixels preceding the pixel in raster order,

deriving a prediction error value for the pixel location under consideration from a received codeword by,

assigning a prescribed initial k value to each context index that is identical to the value used in encoding the bi-level image, wherein a k value is used to compute a number representing a string of consecutive, raster ordered, prediction error values having the first binary value in the same manner employed in encoding the bi-level image being decoded,

determining if the last-received codeword is of the first or second type,

whenever the last-received codeword is of the second type, assigning prediction error values having the first binary value to the number of previously-unassigned pixel locations in a restoration of the encoded bi-level image in raster order starting with the earliest non-assigned location that are indicated by the binary word component of the codeword and assigning a prediction error value having the second binary value to the pixel location following those newly assigned pixel locations, and

whenever the last-received codeword is of the first type,

identifying the k value assigned to the context index associated with the earliest pixel location in the restoration image not yet assigned a prediction error value, and

assigning prediction error values having the first binary value to the number of previously-unassigned pixel locations that are indicated by the identified k value in the restoration image in raster order starting with the earliest non-assigned location, and

upon completion of assigning prediction error values in connection with the processing of the last-received codeword, adjusting the k value assigned to the context index associated with pixel location that begins the string of prediction error values just assigned by increasing the k value by a prescribed amount employed in the encoding of the bi-level image being decoded if the codeword is of the first type and decreasing the k value by a prescribed amount employed in the encoding of the bi-level image being decoded if the codeword is of the second type;

comparing in raster order the prediction error assigned to a pixel location of the restoration image and the predicted pixel value for that location using an exclusive OR process such that whenever the prediction error value is the first binary value the corresponding predicted pixel value is not changed, and whenever the prediction error value is the second binary value the corresponding predicted pixel value is flipped to its opposite binary value;

designating the result of each prediction error and predicted pixel value comparison as a restored pixel value for the associated pixel location in the restoration image.